Task 4 Problem Area Identification Results for Potomac

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Introduction

Old infrastructure, inconsistent design criteria, and possibly climate change, are contributing to repeated and increasingly frequent flooding events in The City of Alexandria, Virginia. The purpose of the Stormwater Capacity Analysis Project is to provide a program to analyze storm sewer capacity issues, identify problem areas, develop and prioritize solutions, and provide support for public outreach and education. The Project consists of four major subtasks related to the model development and modeling. These four tasks and related documentation are listed below.

- Task 1 – Review and propose revisions to the City's stormwater design criteria.
  - *Updated Precipitation Frequency Results and Synthesis of New IDF Curves for the City of Alexandria, Virginia* (CH2M HILL, 2009a)
  - *Sea Level Rise Potential for the City of Alexandria, Virginia* (CH2M HILL, 2009b)
  - *Rainfall Frequency and Global Change Model Options for the City of Alexandria* (CH2M HILL, 2011)
- Task 2 – Analyze the City's stormwater collection system capacity.
  - *Inlet Capacity Analysis for City of Alexandria Storm Sewer Capacity Analysis* (CH2M HILL, 2012)
  - *Stormwater Capacity Analysis for Potomac River Watershed, City of Alexandria, Virginia* (CH2M HILL, 2016)
- Task 3 – Survey collection system facilities on pipes 24 inches and larger to fill data gaps.[1]
  - *City of Alexandria Storm Sewer Capacity Analysis (CASSCA) Potomac River Condition Assessment* (Baker, 2015)
- Task 4 – Identify problem areas and suggest solutions.
  - *Task 4 Evaluation Criteria Scoring Systems* (CH2M HILL, 2014)

The Project is being implemented in phases by watershed. The watersheds include Hooffs Run, Four Mile Run, Holmes Run, Cameron Run, Taylor Run, Strawberry Run, Backlick Run, and Potomac River.

This Technical Memorandum (TM) describes Task 4.1, Problems in the Potomac River Watershed. The hydrologic and hydraulic analyses were documented in the Draft Stormwater Capacity Analysis for Potomac River Watershed, City of Alexandria, Virginia (CH2M HILL, 2016). During Task 4.1, the output from the collection system model was used, in conjunction with additional data inputs, to prioritize problem areas through a weighted scoring system documented in *Task 4 Evaluation Criteria Scoring Systems* (CH2M HILL, 2014). Based on the prioritized scores presented in the Task 4 Scoring System TM, a select set of problem areas was grouped geographically into high priority problem areas identified as locations for future solutions. Alternative solutions were developed for other watersheds, but budget constraints prevented development of solutions for all watersheds. The Potomac River Watershed was identified as the lowest priority for development of solutions because ongoing development in large portions of the watershed created greater uncertainty in the available data. Development of solutions for Potomac River Watershed can be completed as data and funds are available.

Problem Identification Approach

The focus of Task 4.1 is the prioritization of identified problems. The priority of the problem is a function of the severity and probability of flooding as well as consequences of flooding if it were to occur. As a means of accounting for severity, probability, and consequences of flooding, a prioritization process was developed based on several evaluation criteria. The prioritization process includes several distinct steps:

- **Define evaluation criteria** – The following evaluation criteria were defined during the Task 4 workshop with input from City of Alexandria staff (provided in no particular order):
  - Urban drainage/flooding (flooding or surcharging at junctions)
  - Public identification of problem
  - City staff identification of problem (including condition assessment results)
  - Proximity to critical infrastructure
  - Proximity to critical roadways
  - Lack of opportunity for overland relief
- **Define scoring system** – A scoring system was developed for each evaluation criteria to provide a method for ranking problems within the evaluation criteria.
- **Weight evaluation criteria** – Each evaluation criterion was assigned a weight (0-100) based on City Staff average weight provided during the Task 4 workshop (Table 1). The weights quantify the relative importance of each evaluation criteria and build a defensible foundation for problem ranking.
- **Score and rank problems** – Problems will be identified and ranked using the problem area evaluation scoring system and weighting of those evaluation criteria.

A score of 0 to 10 was assigned to each stormwater junction in the system for each evaluation criteria. Weights were then applied to the score calculated for each evaluation criteria to come up with an overall score for each junction. The overall junction scores, which are presented in this TM, were used to rank problems. The individual junction scores were used to group junctions and pipes with high scores in close proximity into high priority problem areas. Solutions will be investigated for the highest priority problem areas.

The problem area evaluation criteria and scoring systems are defined in greater detail in Task 4 Scoring Systems TM (CH2M HILL, 2014).

TABLE 1
Problem Area Evaluation Criteria Weights
City of Alexandria Storm Sewer Capacity Analysis – Potomac

Problem Area Evaluation Criteria	Weight	Normalized Weight
Urban Drainage/Flooding	90	23.1
Public Identification of Problem	73	18.8
City Staff Identification of Problem	75	19.3
Proximity to Critical Infrastructure	58	14.9
Proximity to Critical Roadways	38	9.8
Opportunity for Overland Relief	55	14.1
Total	389	100

Results

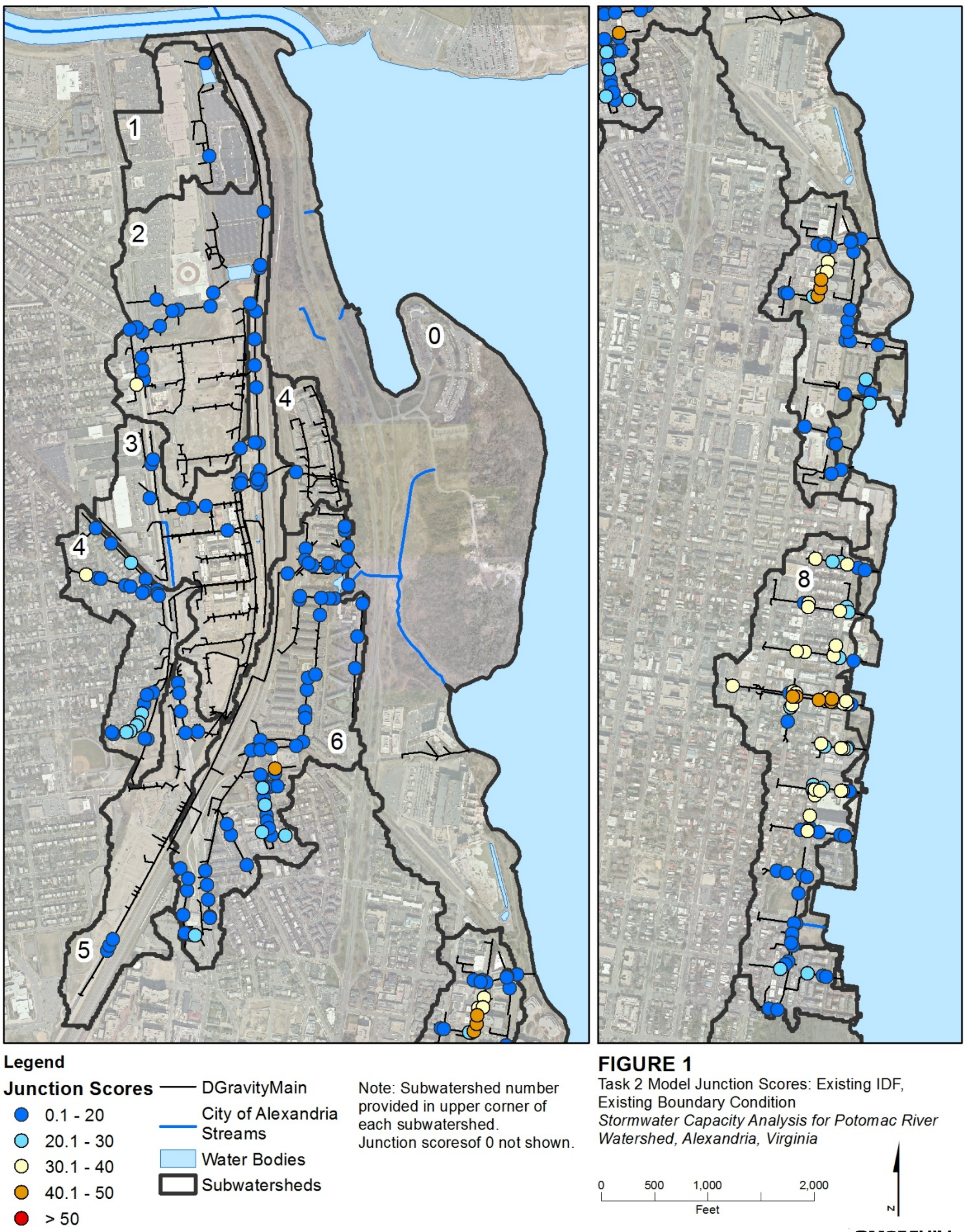
Table 2 provides a summary of the range of problem identification scores found in Potomac River. Figure 1 is a summary of problem identification scores for junctions in Potomac River Watershed.

TABLE 2
Potomac River Problem ID Scores
City of Alexandria Storm Sewer Capacity Analysis – Potomac

Problem ID Score	Count of Junctions	Percent of Total
0	1,136	81.0
0.1 – 20	194	13.8
20.1 – 30	29	2.1
30.1 – 40	34	2.4
40.1 – 50	9	0.6
>50	0	0.0
Total	**1,402**	**100**

Attachment 1 provides a prioritized list of the highest scoring 3.1 percent of the junctions in the Potomac River Watershed. This equates to a score of about 30 or above and includes 16.2 percent of the junctions that were given a score over 0. The majority of these junctions have been grouped into seven high priority problem areas. Junctions that scored over 30 that are not near or connected to other junctions with a score over 30 were not included in a high priority problem area.

FIGURE 1
Potomac River Watershed Problem Identification Score Results
City of Alexandria Storm Sewer Capacity Analysis – Potomac



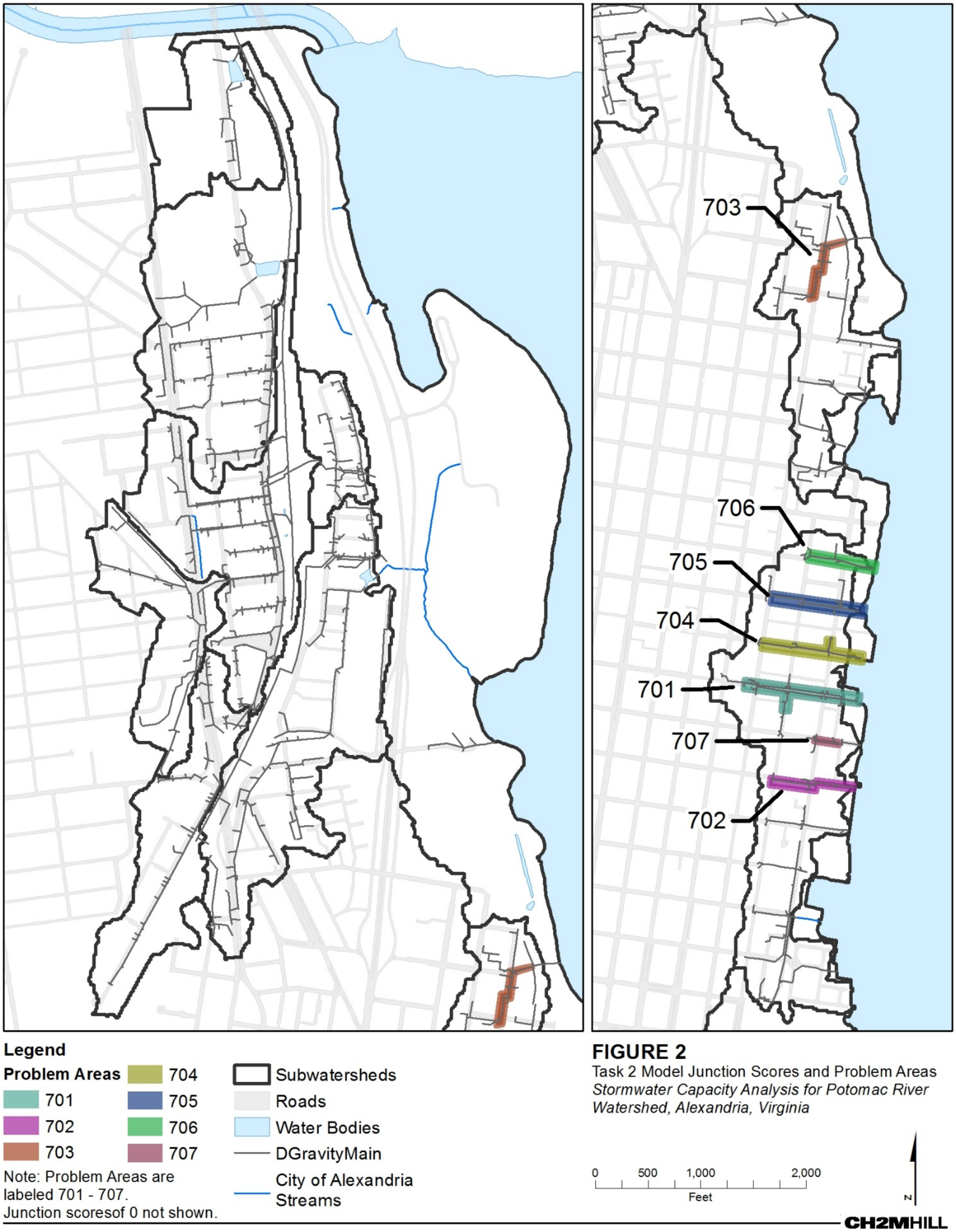
The seven high-priority problem area delineations are shown in Figure 2. The problem areas identified are limited to the waterfront area of Old Town Alexandria. Problem identification scoring is heavily influenced by flooding and the Task 2 model of the Potomac River Watershed predicts significant flooding near the waterfront. The flooding predicted in Old Town is due in part to the conservative nature of the model, which assumes that high tide and the peak rainfall intensity occur simultaneously. This prevents stormwater from draining out of the system through the outfalls, causing flooding. The problem area delineations are relatively small in terms of pipe length and drainage area because the storm sewer system in this area of Old Town consists of short lengths of pipe draining directly to the Potomac River.

Problem Area 703 is downstream of a detention chamber in the north east corner of Montgomery Park at the intersection of First Street and Fairfax Street. Though the detention chamber was included in the Task 2 capacity model, limited information was available on the size of the storage facility and the outlet control. For this reason, additional survey and more detailed modeling is recommended before developing solutions for this area.

While the focus of this study is on drainage issues associated with drainage conveyance systems in the City of Alexandria that are designed for the 10-year storm, the City recognizes that flooding can also result from flood crest elevations in the surrounding rivers, which result from larger storms and/or storm surge events and have much longer response times to rainfall. For example, the City has embarked on a flood mitigation project for the Potomac River waterfront and has conducted similar studies for Four Mile Run and Cameron Run that are in various stages of development. The City's Department of Project Implementation has completed the Potomac River Waterfront Flood Mitigation Study (URS, 2010) and schematic designs for the Waterfront Flood Mitigation Project on the Potomac River (URS, 2014), which is based on the Alexandria Waterfront Small Area Plan, completed by the Department of Planning and Zoning in 2012. The Waterfront Flood Mitigation Project includes a number of elements, including a new flood wall or bulkhead, a promenade and park east of Union Street, between Queen Street in the north and Wolf Street to the south, and two new pump stations.

To allow for interior drainage behind the flood wall, the schematic design for the project includes bypasses for drainage areas west of Union Street to new outfalls, and for drainage east of Union Street there are two new stormwater pump stations proposed just behind the bulkhead near the waterfront: No.1 is just north of Prince Street with a drainage area of 7.98 acres, and No. 2 just south of Queen Street with a drainage area of 1.74 acres. These stations should alleviate flooding that would have resulted from high downstream hydraulic boundary conditions at the outfalls in that portion of the Potomac drainage area of the City, either from high tide and sea level rise or flood stage in the Potomac River.

FIGURE 2
Potomac River Watershed High Priority Area Delineations
City of Alexandria Storm Sewer Capacity Analysis – Potomac



References

Baker. 2015. *City of Alexandria Storm Sewer Capacity Analysis (CASSCA) Potomac River Sewershed Condition Assessment.* Prepared for City of Alexandria. January 12. (Revised May 26, 2015)

CH2M HILL. 2009a. *Updated Precipitation Frequency Results and Synthesis of New IDF Curves for the City of Alexandria, Virginia.* Prepared for City of Alexandria Transportation & Environmental Services Department. May 1.

CH2M HILL. 2009b. *Sea Level Rise Potential for the City of Alexandria, Virginia.* Prepared for City of Alexandria Transportation & Environmental Services Department. June 12.

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CH2M HILL. 2012. *Inlet Capacity Analysis for City of Alexandria Storm Sewer Capacity Analysis*. Prepared for the City of Alexandria Transportation & Environmental Services Department. September 12.

CH2M HILL. 2014. *Task 4 Evaluation Criteria Scoring Systems.* Prepared for the City of Alexandria Transportation & Environmental Services Department. March 19.

CH2M HILL. 2016. *Stormwater Capacity Analysis for Potomac River Watershed, City of Alexandria, Virginia.* Prepared for the City of Alexandria Transportation & Environmental Services Department. February.

URS. 2010. *Potomac River Waterfront Flood Mitigation Study: Evaluation and Recommendation of Mitigation Measures.* Prepared for the City of Alexandria. July.

URS. 2014. *Waterfront Flood Mitigation Project Schematic Design*. Prepared for the City of Alexandria Department of Project implementation. July 31.

Attachment 1
Potomac River Problem Identification Results

Potomac River Problem ID Results

Criteria Weights	Weight	Normalized Weight
Insufficient Pipe Capacity	90	23.1%
Public ID of Problem	73	18.8%
City Staff ID of Problem	75	19.3%
Prox. to Critical Infra.	58	14.9%
Prox. to Critical Roads	38	9.8%
Lack of Opp. for Relief	55	14.1%
Total	**389**	**100.0%**

				Raw Junction Score (0 - 10)						Weighted Junction Scores						
FacilityID	Capacity	Flood Volume (ft^3)	Duration of Flooding (hrs)	Urban Drainage/ Flooding	Public ID of Problem	City ID of Problem	Proximity to Critical Infrastructure	Proximity to Critical Roadways	Lack of Opportunity for Overland Relief	Urban Drainage/ Flooding	Public ID of Problem	City ID of Problem	Proximity to Critical Infrastructure	Proximity to Critical Roadways	Lack of Opportunity for Overland Relief	Total Score
002943SMH	Flooded	37,248	3.6	10	0	0	0	8	10.0	23.1	0.0	0.0	0.0	7.8	14.1	45.0
007209IN	Flooded	1,149	0.4	8	0	0	0	8	10.0	18.5	0.0	0.0	0.0	7.8	14.1	40.4
002949SMH	Flooded	6,435	0.9	8	0	0	0	8	10.0	18.5	0.0	0.0	0.0	7.8	14.1	40.4
002958SMH	Flooded	3,883	0.6	8	0	0	0	8	10.0	18.5	0.0	0.0	0.0	7.8	14.1	40.4
002388SMH	Flooded	1,366	1.4	9	0	0	0	8	8.3	20.8	0.0	0.0	0.0	7.8	11.8	40.4
002389SMH	Flooded	6,957	2.8	9	0	0	0	8	8.3	20.8	0.0	0.0	0.0	7.8	11.8	40.4
002390SMH	Flooded	4,090	2.8	9	0	0	0	8	8.3	20.8	0.0	0.0	0.0	7.8	11.8	40.4
002938SMH	Flooded	11,101	4.2	10	0	0	0	8	6.7	23.1	0.0	0.0	0.0	7.8	9.4	40.3
002956SMH	Flooded	12,720	1.9	10	0	0	0	8	6.7	23.1	0.0	0.0	0.0	7.8	9.4	40.3
002486SMH	Flooded	1,112	0.4	8	5	0	0	2	6.7	18.5	9.4	0.0	0.0	2.0	9.4	39.2
002391SMH	Flooded	454	0.6	8	0	0	0	8	8.3	18.5	0.0	0.0	0.0	7.8	11.8	38.1
002392SMH	Flooded	2,918	0.7	8	0	0	0	8	8.3	18.5	0.0	0.0	0.0	7.8	11.8	38.1
002939SMH	Flooded	3,756	3.0	9	0	0	0	8	6.7	20.8	0.0	0.0	0.0	7.8	9.4	38.0
002940SMH	Flooded	1,914	2.6	9	0	0	0	8	6.7	20.8	0.0	0.0	0.0	7.8	9.4	38.0
006285IN	Flooded	1,085	0.3	8	0	0	0	10	6.7	18.5	0.0	0.0	0.0	9.8	9.4	37.7
002506SMH	Flooded	4,271	1.0	9	0	0	0	2	10.0	20.8	0.0	0.0	0.0	2.0	14.1	36.9
002951SMH	Flooded	620	0.2	8	0	0	0	8	6.7	18.5	0.0	0.0	0.0	7.8	9.4	35.7
002957SMH	Flooded	4,605	0.8	8	0	0	0	8	6.7	18.5	0.0	0.0	0.0	7.8	9.4	35.7
002962SMH	Flooded	147	0.1	8	0	0	0	8	6.7	18.5	0.0	0.0	0.0	7.8	9.4	35.7
008259IN	Flooded	927	0.4	8	0	0	0	2	10.0	18.5	0.0	0.0	0.0	2.0	14.1	34.5
002483SMH	Flooded	4,772	0.7	8	0	0	0	2	10.0	18.5	0.0	0.0	0.0	2.0	14.1	34.5
002945SMH	Flooded	9,692	1.3	9	0	0	0	2	8.3	20.8	0.0	0.0	0.0	2.0	11.8	34.5
002920SMH	Flooded	12,262	1.5	10	0	0	0	2	6.7	23.1	0.0	0.0	0.0	2.0	9.4	34.5
002936SMH	Flooded	9,582	5.4	10	0	0	0	2	6.7	23.1	0.0	0.0	0.0	2.0	9.4	34.5
005162IN	Flooded	362	0.3	8	0	0	0	8	5.0	18.5	0.0	0.0	0.0	7.8	7.1	33.4
005173IN	Flooded	2,614	0.5	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
007292IN	Flooded	3,450	0.9	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002469SMH	Flooded	3,071	0.6	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002494SMH	Flooded	660	0.3	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002503SMH	Flooded	2,212	0.7	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002504SMH	Flooded	2,770	0.8	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002953SMH	Flooded	2,436	0.4	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002955SMH	Flooded	7,409	0.8	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
002966SMH	Flooded	1,495	0.6	8	0	0	0	2	8.3	18.5	0.0	0.0	0.0	2.0	11.8	32.2
005304IN	Flooded	6,988	2.4	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002479SMH	Flooded	8,457	1.2	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002933SMH	Flooded	2,678	1.4	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002935SMH	Flooded	7,888	4.7	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002941SMH	Flooded	9,262	3.0	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002946SMH	Flooded	6,822	2.3	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002948SMH	Flooded	5,691	3.0	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
002973SMH	Flooded	5,345	2.9	9	0	0	0	2	6.7	20.8	0.0	0.0	0.0	2.0	9.4	32.2
0001091ND	Flooded	9	0.5	8	0	0	0	8	3.3	18.5	0.0	0.0	0.0	7.8	4.7	31.0
007172IN	Flooded	1,921	0.4	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
0001090ND	Flooded	16	1.6	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002450SMH	Flooded	77	0.1	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002480SMH	Flooded	2,659	0.9	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002484SMH	Flooded	416	0.4	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8

FacilityID	Capacity	Flood Volume (ft^3)	Duration of Flooding (hrs)	Raw Junction Score (0 - 10) Urban Drainage/ Flooding	Public ID of Problem	City ID of Problem	Proximity to Critical Infrastructure	Proximity to Critical Roadways	Lack of Opportunity for Overland Relief	Weighted Junction Scores Urban Drainage/ Flooding	Public ID of Problem	City ID of Problem	Proximity to Critical Infrastructure	Proximity to Critical Roadways	Lack of Opportunity for Overland Relief	Total Score
002485SMH	Flooded	3,289	0.6	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002505SMH	Flooded	476	0.6	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002970SMH	Flooded	244	0.6	8	0	0	0	2	6.7	18.5	0.0	0.0	0.0	2.0	9.4	29.8
002078ND	Flooded	1,873	1.5	9	0	0	0	2	5.0	20.8	0.0	0.0	0.0	2.0	7.1	29.8
002947SMH	Flooded	7,806	3.0	9	0	0	0	2	5.0	20.8	0.0	0.0	0.0	2.0	7.1	29.8